

Basement Teehie

Issue #1 - Winter, 2012/2013



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Tools Of the Trade

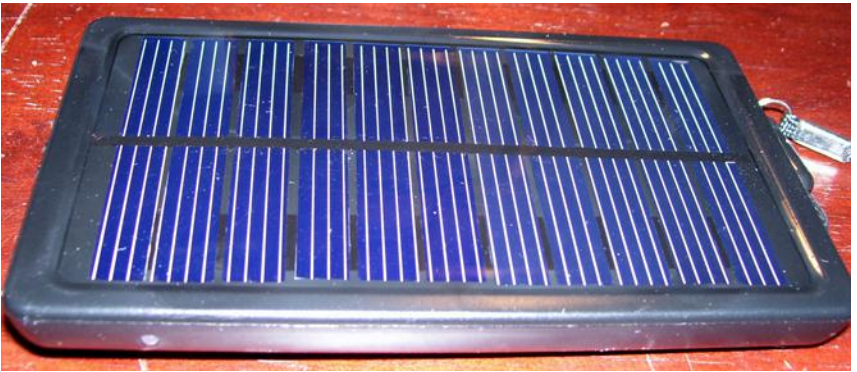
The crew at Dog Solitude are always looking for useful, inexpensive additions to our kits. We have a number of local places that we check on an irregular basis. There are the usual places like Home Depot, Lowes, and Radio Shack. We also hit more mundane places like Wal-Mart, Target dollar stores, and the discount places like Ocean State Job Lot, Bennys, and Big Lots. Then there are the hamfests, gun shows, and army/navy stores where you can pick up a lot of useful stuff. We don't spend a lot of money on most of this stuff, you can do a pretty good job of fleshing out your kit for a few bucks at the dollar stores and odd lot/job lot stores. Other times you find things on clearance. Many of us buy our police scanners when Radio Shack dumps their old models. You can get a decent model for 50% (or even less) of its original price. You just have to keep your eyes open. In this article, we're going to show you some of the smaller items that have found their way into our kits.



Most of us here have some form of EDC knife that we keep on our person for all those times that you need a cutting edge. Leatherman Tools and Swiss Army Knives (SAK) figure in heavily. They have the advantage of also having various small tools on them in addition to the knife blade. Medium-sized SAKs such as the Victorinox Super Tinker weigh very little, fit discretely in a pocket, have all the most-needed tools, and are reasonably priced. The more survivalist-oriented among us

also like to keep a small discrete cutting edge handy.

This is a Buck Smidgen neck knife, designed by Doug Hartsook, and made in the U.S.A. As you can see, the entire knife is just under 4 inches long, with a blade length of 1 7/8". The knife costs \$23 on Buck's web site, but you can buy it for less elsewhere. I have found that the Smidgen disappears under a t-shirt, and like any other proper EDC you don't know it's there until you need it. For those instances where just need a small utility knife for day-to-day tasks, this is one of the better values out there.



All of us are into getting as off the grid as possible. As a result we experiment a lot with alternative energy sources, preferably as inexpensive as possible. Wildflower found these at one of his usual procurement sources. It is a solar charger for USB-powered devices. The label on the back says it has an internal 2700 mAh Li-ion battery. So far I've found that it does a good job at charging my cellphone as long as there's enough sunlight. It also has a built-in 3 LED flashlight.

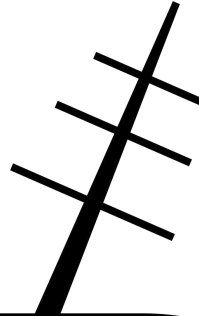
The Rat Shack

For many of us, Radio Shack was "The Place" simply because it was the only place you could easily get to. They were in every from mall and shopping plaza, and also in remote out-of-the-way places. The ones you found out in the back of beyond were especially interesting. You often found long-discontinued items in them, as I discovered after visiting one that was just off The Northway in the Adirondacks. Radio Shack was, if nothing else, an adequate source of tools, parts, and interesting gadgets up until the mid-1990s when they mostly became a retailer of wireless phones. Even at their low point however, there were always a few hacker "must-haves" available at Rat Shack. The 'Shack was also always a prime source for various phone accessories and for police scanner-type receivers. In many areas, Radio Shack has been replaced by a local electronics dealer. These places have been making a comeback, and chances are if you live near a decent-sized city there is one within driving distance. If not however, I'm sure there is at least one local Radio Shack nearby.

Radio Shack was where I got my first police scanner, soldering iron, and electronic tools. It also served as my primary source of parts for various projects. Over the years, Radio Shack's level of service and variety of parts has waxed and waned. During the mid-1990s it hit an all-time low, and now it appears

that they are getting back into supporting the Maker market. Radio Shack did have BASIC Stamps and various sensors for sale in their stores, and now some stores are carrying the Arudino microcontrollers. Some stores have Forrest Mims' excellent **Engineer's Mini-Notebook** Series, and his **Getting Started in Electronics** book that gave many of us our start in the hobby. What you have to do is find the nearby Radio Shack that caters to the hobbyist market. As a general rule it will not be a store located in a mall.

Besides the Forrest Mims books, you at the very least should get one of their battery-operated amplified speakers, RS#277-1008, and an inductive suction-cup microphone, a/k/a "Recorder Telephone Pickup", RS#44-533. Arduinos are nice, and you'll probably want one to experiment with, but you can find them for less money than what Rat Shack charges. Radio Shack multimeters are OK for a beginning hobbyist, especially when you find them on clearance. The same applies to their police scanners. In fact, most hobbyists make it a habit of visiting their local Radio Shacks around the time of their clearance sales. In extreme cases you can find stuff on clearance for twenty to thirty percent of its original price. Radio Shack has been known to offer stuff that hobbyists of our particular bent find cool, and then clearance it out at a steep discount after a short while because the item did not sell well among the more mundane customers.



The Listening Post

by Ed Lyle

Welcome to "The Listening Post", my column on eavesdropping the electromagnetic ether. The more respectable hobbyists call it "scanner listening" or "shortwave listening". The government calls it SIGINT - Signals Intelligence, COMINT - Communications Intelligence, ELINT - Electronic Intelligence, or MASINT - Measurements and Signature

Intelligence, depending on what they're doing and some other things. For our purposes, it's all the same.

I'm going to start this series with some sage advice from the late Steve Uhrig of SWS Security, one of the more interesting people I have had the pleasure of being acquainted with. While Steve passed away some years ago his website remains online at http://www.swssec.com/white_paper.html, and contains some useful bits and pieces of information. Without further ado, some wisdom from the past...

===BEGIN===

Following is a sanitized excerpt from a message exchanged with a gentleman starting in the field.

Since it might be general interest, I am copying some here.

My initial advice to the gentleman was not to spend any money on anything, merely do a lot of homework and research and learn for free before dropping a penny into hardware. This is my universal advice to newcomers. All the used equipment I have originally was purchased new by someone, then sold to me usually at a large loss for many reasons. Much of the stuff comes from new enthusiasts who get carried away, from their widows or former spouses, or former employers who have a bunch of crap some idiot in security bought from a spy shop then left to get a job more suited to his abilities, like flipping burgers.

If you do want to make an investment, first put the money into something that goes between your ears, like training, basic electricity and electronics courses, or textbooks like the one described below if schooling is not practical or you aren't serious

enough to make the commitment.

You can always get your money back out of a used receiver if you lose interest. This is not true of most sweep equipment bought new or used. Sweep equipment is much like new cars in a way. The instant you unpack it you have cut its value by a third, permanently. If it lays around and gets dust and fingerprints on it, there goes another third.

Then your ex sells it to me for 10% of what you paid for it, and I clean it up, replace the batteries, calibrate it and resell it for twice that, and someone gets a great deal because you spent money you shouldn't. You lose and everyone else wins.

Don't buy hardware until you know what you will do with it and can justify it. Unless you are a professional, and if you are you don't need my advice, dream about the equipment if you want to, but don't buy it.

Very, very few persons will ever earn enough sweeping to pay for their equipment. BUYING EQUIPMENT IS AN EXPENSE, NOT AN INVESTMENT, FOR MOST PEOPLE, AND THAT PROBABLY INCLUDES YOU. Don't fool yourself.

Yes, I'm shouting.

When a guy who sells equipment tells you not to buy it, maybe he's actually telling you the truth.

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i have an XXX background and a pretty good set of ears and was just wondering if it was still a bad idea to maybe tinker around with an RF transmitter sweeper to get my ears used to combing through the key frequencies you specified in your articles;

and if you do have a good, reliable used unit, i wouldn't mind having a new toy to play with!

The best universal tool for you, in my opinion, would be a decent general coverage shortwave/VHF/UHF receiver.

You can manually tune the spectrum and every practical bug frequency up to 2 gigs. This does not include the high threat 2.4 gig video stuff, but there are cheap ways to sniff them with separate equipment.

You very likely would have a lot of fun doing some shortwave listening as well as learning in the process. And if you have kids, it's something you can do together and actually will drag many kids away from the web or the teevee. Have you ever spent an evening listening to Radio Moscow, or Radio Nederlands, or HCJB (Heralding Christ Jesus' Blessings, as they have been saying for at least 35 years) in Quito, Ecuador or Radio Havana? Fascinating. They still play music from the 40s and 50s, and you can still find Green Hornet and Fibber McGee and Mollie shows. And a very different view of international news, especially during a crisis.

Manual tuning was the way it all was done until maybe 25 years ago when stuff like the Scanlock was introduced. Most of the government guys trained on and swear by Mason A2 or A3 receivers which were \$30K to the government 30 years ago, and today

a modern \$2000 receiver is much better.

An ICOM R8500 would be a good choice. Read more about frequency coverage elsewhere before buying. Scanner newsgroups like rec.radio.scanner is worth the noise level from the education you will pick up.

Full coverage is important for sweeping. Listening to cellular calls is interesting for perhaps 30 seconds, then boring to most. Probably illegal to listen. Not illegal to sell the equipment secondhand or to possess it.

You can get by with real simple antennas, perhaps even make a simple 'coat hanger groundplane' as a learning experience out of a connector and some coat hangers which will work perfectly fine for casual listening and cost under \$5. Or you can buy a discone antenna which would work well and is what many/most of us use. You would need some feedline which would be something you could assemble yourself also as a learning experience.

I would recommend any issue in the last 10 years of 'The Radio Amateur's Handbook' published by the American Radio Relay League aka ARRL. <http://www.arrl.org/>. This is a universal handbook covering everything about communications theory from the very beginning to the most modern. Virtually everyone has one around for reference, formulas, charts, etc. Since theory doesn't change, yet they publish the thing annually, it doesn't much matter which issue you get. I think my newest one is a 1972 and I have one which belonged to my dad from 1942 which was before I

was born.

The later editions have more about microwave and satellites and modern stuff, and older ones have more about stuff like teletype, vacuum tubes and earlier theory. Ideally you would want an older and a newer one, but for now anything you can find will be adequate. Check ebay for older ones. Don't pay collector's prices, though. You don't want an antique, you want a beat up reference book with coffee stains on it, for a decent price (like \$20-\$25 max). You want the hard copy edition, NOT the CD. Nothing beats being able to carry the book to your bench, or photocopy a chart, or read it sitting on the potty.

===END===

The advice is solid and the Icom R8500 is an excellent receiver, but used ones average \$1700 on Ebay. Those of us on a budget need alternatives. Ebay is often called "Epay" for a reason. Items for sale on the auction site often command top dollar. I've seen ham shops sell R8500s used for under \$900. The typical poor man's interceptor visits local pawnshops and hamfests looking for affordable gear. You can find a decent 1990s vintage high-end police scanner like a Uniden BC9000 or Radio Shack PRO-2006 and a shortwave receiver for under \$200 if you look around. That gives you reception from 150 KHz. to 1300 MHz.

My first book that got me into all this was a copy

of Audel's Radiomans Guide that I picked up at a library book sale for a couple bucks, but I later went and bought a new ARRL Handbook at a local hamfest. My recent hamfest visit showed ARRL Handbooks selling for as little as a buck or two. A quick look on Epay showed a number of editions from the last ten years going for a few bucks each. Many of those auctions ended with no sale, just like the many unsold copies I've seen at hamfests.

Shortwave Listening (SWLing) is fun and you come across some interesting stuff in the 150 KHz. to 30 MHz. spectrum. Your first interests however are probably going to be in the more local VHF and UHF bands between 25 MHz. and 1300 MHz. (or 1.3 GHz.) "Local" is a such a relative term as the VHF low and mid bands (25-88 MHz.) can be heard at extended distances with the right antenna. Even stations in the VHF high band (138-174 MHz.) can be heard out to the 100+ mile mark depending on terrain. The item of VHF/UHF RF interception used by the beginner is likely to be the ubiquitous police scanner. They are common, cheap, and do the job well enough for their intended purpose. You can find units that come close to equalling a professional communications receiver in performance, and simple models that are good for keeping an ear on a couple frequencies of interest.

During the scanner hacker heyday of the early 1990s, the late Bill Cheek wrote a three volume Scanner Modification Handbook series that was based around the excellent Radio Shack PRO-2004, PRO-2005, and PRO-2006 scanners, although applicable towards other models too. This book series details various performance-enhancing

modifications one can perform to consumer grade police scanners that bring them closer to the level of professional-grade gear. They are available used on Amazon for a few bucks each and are a good addition to your library. Cheek also published a newsletter, World Scanner Report that contained similar material. A complete set of back issues approaches unobtainium these days in availability, but if you ask around the online scanner forums you'll probably find a set for sale among all the hosers flaming you.

By now if you haven't realized it, this poor man's approach entails the application of a little elbow grease. That ARRL Handbook is going to give you a pretty good education in electronics, and you'll want to put together a small electronics workbench and tool-kit so you can do some work and roll your own gear eventually. Other articles in this fine publication talk about the basics of that, so I'll spare you the repetition of seeing it again. It always bears repeating though that an overabundance of toys will never equal skill plus some good basic gear.

When it comes to receiving gear, most novice interceptors opt for the Radio Shack solution. Radio Shack has a long-standing reputation of offering adequate, if not well-performing shortwave receivers and VHF/UHF scanning receivers. They were my initial selection when I was a beginner, and several Radio Shack receivers still grace the listening post here. Radio Shack gear is actually another manufacturer's rebranded equipment. Their store-brand shortwave receivers were made by Sangean. The scanners are GRE or Uniden (Bearcat). While their offerings are not as extensive

as they were in the past, they still remain a usable source for those of you who don't have alternatives.

Taking a step above the Radio Shack offerings are the ham-grade communications receivers offered by Icom, Kenwood, and Yaesu. All three manufacturers have sold numerous models over the past 25+ years, and there are plenty of quality used items available via hobbyist circles. The Eham Reviews website at <http://www.eham.net/reviews/> has many reviews of older equipment to help you with a selection. This category offers a good balance of performance and cost. Beyond the realm of ham gear are the professional receivers used by government agencies. This is when you start looking at names like CEI, Watkins Johnson, Collins, Singer/Stoddart, Astro, and Nems-Clarke. The vast majority of this gear is of an older vintage, but it still holds its own among the newer stuff.

In the next installment of this article series we will take a look at some specific models of communications receivers and discuss antenna systems you can use with them. Until then, keep your headphones on.



Radio Redux

(An earlier version of this article was published in the Autumn, 2012 issue of 2600: The Hacker Quarterly. Visit <http://www.2600.com/> for more information.)

RF... Of all the aspects of electronics, many of us find the black art of radio fascinating to the point where we pursue the ether to the exclusion of other technological studies. Far from deliberately limiting ourselves, we find that non-ionizing radiation acts different across the vast spectrum of signals, and that the pursuit of this black art encompasses analog, digital, high-voltage, small signal, and even some mechanical. It starts with a spin of the dial, or in the old days a click of the tuner. One boring night between 450 and 1600 Kilohertz you discover that some of the stations are from way out of town, or for those old enough to remember "Never The Same Color", a late summer afternoon between channels 2 and 5 often displayed far-away images. Maybe your dad or grandad owned a CB or was a ham. Some of us had parents who were volunteer firefighters, and would turn on the Plectron's monitor function during the summer to hear fire calls from half a country away. To most people this was simply an occasional anomaly. Perhaps it was somewhat interesting, but not worth further attention. A few kindred spirits however saw it as the first glimpse of an invisible world that we've been listening to ever since.

Back in the day, us newbie radio enthusiasts started out with a Mr. Microphone, or a walkie-talkie on 49 MHz. or CB channel 14. If you were really getting into it, you picked up one of those multiband portable receivers from Radio Shack that had shortwave and VHF/UHF "public safety" bands. Maybe you were lucky enough to get a police scanner or tabletop shortwave receiver. From there, it was getting a CB station on the air, maybe even one of the models with sideband and/or extended frequency coverage that the hardcore CBers referred to as "uppers and lowers". Older used gear was definitely within the budget of all but the most destitute hobbyists. CB was fun, but if you were really into it, you went and got "the ticket": your ham radio license. Why only have 40 channels and a few watts of power when for the small effort of learning Morse code and basic electronics you could have access

Getting Your Antenna Up

When you start exploring the electromagnetic spectrum, especially at the lower (<30 MHz.) frequencies, you will need to erect an external antenna. This is typically a wire antenna of some sort. Beginners usually opt for a dipole or longwire. The standard advice is to get something up as long and as high as possible, and towards that end a number of devices are used. I've tried both slingshots and fishing rods with various levels of success, but lost my fair share of 3 oz. sinkers and lug nuts. Then there is also the added weight of the line-throwing device when you are operating out in the field.

A local ham who runs a business selling accessories to fellow hobbyists turned me on to a better way. He uses an arborist's throw bag and slick line. Throw bags are 8-16 ounce nylon or vinyl bags filed with steel or lead shot. They have a metal ring on the top to attach a light weight line. They are used with 1/8" polyethylene rope known as "slick line" in the trade. The slick line is very slippery and slides over bark and branches with ease.

After a couple hours of practice, I was able to consistently place a rope around 50' into a tree with accuracy. Throw bags and slick line should be available at any arborist's supply shop, or you can purchase them from Hamsource at http://www.hamsource.com/throwbag_kit.html.





Featured Techie Space: The Hasty Pastry

This issue's featured techie space is The Hasty Pastry in Cambridge, Massachusetts (USA). The Hasty has its roots in the famous I0pht hacker space from Boston and later Watertown in the same state. I0pht was founded by old-school hackers "Brian Oblivion" and "Count Zero", and their spouses. One side was all computer and electronic hardware, the other a craft space for various art projects and a hat-making business. As members moved out of Boston to the suburbs, the I0pht too found a new home in Watertown.

The exploits of the I0pht earned recognition in government and industry circles. They merged with consulting firm @stake in 2000, and later several former I0pht members rented a space in Cambridge that would become known as The Hasty Pastry.

Have pictures of your techie space you'd like to share? Send them via email to ticom.new.english@gmail.com.





to frequencies up and down the radio spectrum? Some of us even went further than that and got the commercial license, what today is known as the GROL - General Radiotelephone Operators License. A GROL is the sign of someone who either plays with RF professionally, or is seriously interested in doing so.

As an old-school radio hacker from back in the day, I'm pleased to see a revival of interest in wireless topics among the hacker community. While RF hacking waxes and wanes in popularity over the years, there's still a core group of us who pretty much only do radio, and who would like to see more hackers get into it. In this article, I'm going to get into some basic info for those of you who would like to get into RF Hacking, and talk about some of the latest news in the RF Hacking scene.

Where does one begin? Hacking RF usually means learning a bit about electronics. Fortunately, the means to do so is available right on on the 'Net. Do a Google search for "NEETS Navy Electricity Electronics Training Series", and you will find links to a 24 volume set of PDFs that you can download. This is a complete electronics course used by the U.S. Navy to teach their economic draftees, and it's very good. The NEETS series has lot of information on RF, and if you already know something about electronics you could be better than half way there. Then you have the book that we all keep at least one copy of in the library, the quintessential bible of RF hobbyists, regardless of whether they're hams or not. I am talking about The Handbook, also known formally as The ARRL Handbook for Radio Communications (formerly "...for Radio Amateurs.") Any copy published within the past 10 years or so will suffice. The ARRL Handbook has theory, practice, projects, and other useful information. New copies are about \$50. Older used ones are much less. Ideally you should have a copy from every few years going back from the present to the late 1940s so you can get familiar with old tech that still sees a lot of use. You can find used copies at hamfests or on Ebay. You might find yourself collecting old ARRL Handbooks as the DIY material is different from year to year, and at less than \$10 a copy you can put together a pretty impressive collection of ARRL Handbooks for little money. The last three copies I bought, dated 1994, 1979,

There has always been a big controversy between the RF Hackers who have gotten their ham ticket versus those who remain unlicensed. I've been licensed for the past 28 years, and also have a commercial license since I used to do RF professionally. However I have to respect the opinion of those who don't want to deal with the geriatric cranks who often populate the airwaves. I've been licensed since high school, and I'm still considered the "youngster". My attitude is "fuck them", and I hang out with all the cool ham radio people instead, and there are quite a few of us. With that said, many of the cool hams are senior citizens full of practical RF know-how and a willingness to share. They unfortunately don't have much longer on this planet, so you should find them and learn what you can while they are still around. From an experimenter's standpoint, having your ham ticket gives you a lot of spectrum to play with, ranging in frequency from just above the AM broadcast band to the upper microwave region. Hopefully soon there will even be a ham band below AM broadcast that promises all sorts of interesting opportunities. Getting the ticket is easy. The questions and correct answers to all the tests are public information, and most people just simply memorize enough to get a passing grade. While passing the tests is cool, your real education doesn't really begin until you start plying the ether. For those of you who don't want to get the ticket for whatever reasons, there is still a good amount of license-free spectrum you can experiment with. You'll be dealing with Part 15 and Part 95 limitations, but some take it as a challenge. To each their own, I guess.

If you follow ham radio news in magazines like QST and CQ VHF, you'll find that there is always something neat and new going on. Digital modes using a computer's soundcard have gotten to the point where the equipment hears better than you can, and can pull stuff right out of the noise floor. Software-defined radios have gotten to the point where you can buy a hot VHF/UHF receiver the size of a USB stick for under US\$100. Google "FunCube Dongle" or "RTL2832U USB HDTV SDR" for more information. The microwave "weak signal" guys keep going higher and higher in frequency as the equipment for playing up there becomes cheaper and more available. For the moment now, I'd like to talk about two happenings

in the RF scene that are of particular interest for beginners in RF. Both have to do with changes in how the RF spectrum is being used.

Cheap Receivers

Back in the day, I started with a cheap Electra multiband-portable radio that covered the shortwave, and VHF-high public safety bands. It was a tag-sale find, and cost a lot less than a programmable police scanner. A good wideband receiver setup is essential for not only hearing what's out there, but also as one of your first pieces of test equipment to check the quality of signals you might be put on the air.

If you look around, you could probably find a working CEI/WJ RS-125 set-up for a couple hundred bucks at a hamfest, and that would be more receiver than you would know what to with for a while, both in physical size and capability. If you're really lucky, you might even come across an RS-111, better known as the receiver that made G. Gordon Liddy famous. Radio Shack PRO-2004/2005/2006 scanners, the classic model that got most of us into radio hacking, are being offered at a fraction of their original cost. Most of them already have the appropriate mods done of them. For most beginners though, the most likely entry point would be one of the inexpensive USB stick-type SDRs (Software Defined Radio) receivers.

All of this started with the introduction of the FunCube dongle (FCD) . The FCD is a receiver with nominal 64-1700 MHz. frequency coverage (closer to 51.5-2000 MHz. depending on the particular unit.) that uses standard soundcard drivers under Windows, Linux, or OSX. At ~\$175 with shipping to the US (depending on exchange rates), this was up until very recently one of the least expensive ways to buy a wideband receiver.

If \$175 is still too much for you, how about \$20? It was recently discovered that USB DTV dongles with a RTL2832U chipset and an E4000 tuner can be used as wideband SDR receiver with frequency coverage of 62-1700 MHz. At present, this is the least expensive route to get wideband VHF/UHF receive coverage.

For more information, visit the following sites:

<http://www.funcubedongle.com/> - Info on the FCD.

<http://superkuh.com/gnuradio.html> - RTL2832U/E4000 SDR

<http://sdr.osmocom.org/trac/wiki/rtl-sdr> - RTL SDR

<http://zembecowicz.blogspot.com/2012/07/worlds-cheapest-software-defined-radio.html> - Even more RTL SDR info, including compiling software under Debian.

Narrowbanding

Narrowbanding is probably one of the best things to happen to the radio hobbyist scene when it comes to the availability of surplus equipment. I expect over the next year or so for the used market to have a lot of neat stuff available for re-purposing. Narrowbanding is the implementation of an FCC mandate to reduce the amount of spectrum used by land mobile licenses, and double the amount of channels available. Previously, LMR systems ran FM with a maximum 5 KHz. deviation. The new standard calls for 2.5 KHz. The channel spacing will then go from 15 KHz. To 7.5 KHz. All land mobile radio (LMR) users in the VHF-high and UHF bands must switch their systems to a narrowband standard by 2013. All LMR radios made within the past 10 years or so are narrowband compliant, but there is still quite a bit of older stuff in use out there. Commercial radios are built to last!

This means that millions of perfectly serviceable radios will become unusable for LMR use after 2013. While most of them will find their way to developing countries or be scrapped/recycled, there will still be plenty around for hobbyist use. The two meter (144-148 MHz.) and 70 cm (420-450 MHz.) ham bands are directly adjacent to the VHF-high and UHF LMR bands respectively, and LMR gear can moved over to the ham bands with no or little adjustment, 90% of the time.

The best equipment for the hobbyist would be the 50-100 watt mobile radios, and any radio that is front-panel programmable (FPP). An FPP radio is exactly as described, a radio that you can program frequencies in

from the front panel, without the need for a computer with the correct radio service software (RSS), radio interface box (RIB), and programming cable. One of the biggest differences between ham gear and commercial gear is that ham gear is designed to be set by the user to any frequency within the edges of a given ham band, while commercial gear is set to specific channels in the LMR band, usually by a radio shop, that the user is licensed for. So where a ham can simply tune right to 146.52 MHz. for example, a commercial LMR user goes to Channel N and the frequency is pretty irrelevant unless someone wants to listen in with a scanner (assuming the mode is analog FM or P25, and not something like TRBO or NEXEDGE).

Being that LMR users are restricted to specific channels, the equipment can not be ready programmed to go off their licensed frequencies. Older radios had quartz oscillator crystals in them that determined the specific frequency. Some can be programmed directly from the front panel by entering in an unlock code on the panel's keypad, usually after moving a programming jumper on the radio's circuit board or attaching a programming dongle to the radio. Most radios are done with a computer, using the proper RSS, RIB, and programming cable for the specific make and model of radio. In the days of USB ports, the RIB is becoming a thing of the past with a USB programming cable that goes directly from the computer to the radio.

Of the three items, the RIB and cable are the easiest to get. The RSS may be a different story however. Some LMR companies are not too bad with software availability, and may have it available at a reasonable cost (or free) without hassle. Other companies are a different story. They may restrict software availability to "authorized service centers", and discontinue software availability for "obsolete" products. Some companies have been extremely aggressive in going after individuals who "pirate" their software. Motorola is notorious for this. Your mileage may vary.

There are also early synthesized radios that are programmed by burning a PROM or EPROM that is then plugged into the radio. The programmers and chips range in availability from unobtainium to pretty common. Generally speaking, the Motorola stuff using their

proprietary modules and "suitcase programmer", such as the MX-350S handhelds, should be avoided as it's almost impossible to get the stuff to get them reprogrammed. The old GE stuff used more common hardware that has since been reverse engineered by hobbyists, and is available in the ham community if you look and ask around.

The easiest and best option for the beginner RF hobbyist looking to get into "real radios" is an FPP model, as no external equipment is needed to get it up on running on the right frequencies. More likely than not you'll be getting a portable (HT) as that'll be the unit you'll be changing frequencies on most often. There are several types of FPP radios out there. My favorites are the Motorola JT1000, Icom H-16 & U-16, "hamflashed" GE MPA, Kenwood TK-350, and Bendix King LPI (a/k/a U.S. Military PRC-127). If you can find an old Radio Shack simplex repeater box (cat# 190-0345), they work very well with the Icom radios. On the mobile side, a lot of hams like the Kenwood TK-705 (VHF) and TK-805 (UHF). Icom also made the V-100 (VHF) and U-400 (UHF) mobiles that are FPP.

Older crystal controlled radios, in which each frequency is determined by an oscillator crystal inserted into the radio, are generally overlooked by hobbyist types. I've found them a useful source of RF parts, especially when acquired for free. Getting them recrystalled and retuned for ham band frequencies is not too difficult, and they are reliable performers for certain fixed applications where you won't be changing the frequency. Many years ago I came across a Drake TR-22, which is a vintage solid-state crystal-controlled 2 meter rig, that was recrystalled by the previous owner for all the AX.25 packet radio channels in the 145.01-145.09 MHz. region. It also had the 146.52 national simplex frequency in it, and a couple other common simplex channels. The radio cost like \$30, and it made a very handy packet rig. More recently I was given a donation of older vintage VHF-low band (30-50 MHz.) equipment to help out with a project I'm working on. Included was a Motorola Mocom-70 that was recrystalled to operate on the 6 meter band (50-54 MHz.) simplex frequency of 52.525 MHz. Just attach an adequate 12V power source to the radio, and it's all ready to go. Stuff like this, despite its age, will continue to run like a tank for many years to come. When it does break, you can usually

find a scanned copy of the service manual online, and fix it with commonly available electronic components, if you can't find someone with a "parts unit" they'd like to offload. If you come across any Motorola MT-500 portables, you might want to give them a second look. There have been copious ham-related mods done to them, and one gentleman has done a great job converting them for APRS use on the 2 meter ham band.

That leaves the radios that require computer programming. As mentioned previously, getting RSS can be problematic, depending the make/model of your radio. Fortunately, there are plenty of hams who work in the LMR industry, and hams who like to work with surplus commercial gear. Assuming you don't come across as a total jerk or basket-case, they will likely be able to get your radio up on the ham bands. ***Do not ask them for copies of current production RSS, and do not ask them to program non-ham frequencies into your radio.*** I can assure you that the answer will be no, and that future assistance may not be very forthcoming. While hams who work in the LMR industry are for the most part very helpful in helping their fellow hobbyists get surplus commercial gear up and running on the ham bands, they're not going to do anything that will jeopardize their job, such as pirating software or putting someone on a frequency they're not authorized for. With that said, some of the older stuff from companies that are not be around in their original incarnation may be available online if you look around. Downloading and using such obsolete, orphaned software for non-commercial (ham) purposes will probably not cause you grief.

My first commercial portable was a Motorola MT1000. They come in a 99 channel variety, and if you find one you would do well to get it. Those Genesis series radios are true bricks. After that I ran Saber and HT-1000 portables, which are both excellent radios. Some of the early ASTRO Saber radios are also becoming available in the surplus market, which would be a good way to get a P25 handheld. For mobile radios, the two Motorola models to look for are the Maxtrac and the Spectra. Both of those have an accessory jack on the back of the radio that, among other things, gives you unfiltered demodulated audio, like a discriminator tap on a police scanner, which

can be used for monitoring various digital modes such as POCSAG. These radios will also handle data transmission very well. There are plenty of older Spectras, and to a lesser extent Maxtracs, still in active service. Come 2013, they will not be able to be legally used on the LMR bands.

Some of the best radios to come out of the surplus LMR market are the 100 watt remote-mount mobile radios that also see use as base stations. The radio's control head has a nice small footprint that fits anywhere on a workbench, and the RF deck can be placed somewhere out of the way. Motorola Maratrac's are nice, especially if you can get a 99-channel control head for it. The Primo unit in my opinion, however, is the VHF-low band Syntor X9000. Unlike other low-band radios that only cover a portion of the band, the Syntor has full 30-50 MHz. coverage and will operate on both the 10 meter and 6 meter ham bands with up to 128 channels. Syntors have been discontinued for some time now, and are beginning to become like unobtainium. If you find one, grab it and hold onto it!

The Internet is a great resource for ham operators who want to work with surplus LMR radios. Here are a few websites to get you started:

<http://www.gemoto.com/>

<http://www.repeater-builder.com/>

<http://www.batlabs.com/>

Pagers

After seeing my talk on pagers from the original HOPE HackerCon re-released, it occurred to me that not only was it 18 years ago, but that it was time for an update. I then saw the pager article from the Summer, 2011 issue of 2600, and was heartened to discover that the topic still had maintained interest among the hacker community over the years. While pagers have been replaced by wireless devices with SMS and email among the general populace, they remain interesting and useful to the hacker hobbyist, especially those who concentrate on RF.

The first thing I need to say is that monitoring pagers in

the United States is not necessarily illegal. Pager protocols are not encrypted, and their technical specifics are public information. The law applies to common carrier services, that is commercial paging services, and to radio system users who implement encryption. There exist in the land mobile radio bands many paging systems that are licensed under the Business-Industrial Land Mobile Radio (LMR) service, and these are fair game for monitoring. Amateur radio operators have also been known to use POCSAG for communications, and monitoring them is fine too. What may apply from a Federal Law standpoint is the section of the Communications Act of 1934 that makes it illegal to disclose or take advantage of the contents of an electronic communication intercepted by a third party. There has been some discussion as to whether that would only apply to common carrier services, or to radio communications in general, but legal discussion of the various communication laws is beyond the scope of this article.

As I've previously mentioned, pagers have mostly been supplanted by SMS and wireless device email. This has had two consequences from the hobbyist standpoint. The first is that the common carrier pager frequencies, at least here in New England, have but a fraction of their traffic compared to the 1990s. The second, and most important as far as this article is concerned, is that there has been an influx of surplus equipment that can be re-purposed for hobbyist experimentation. This is in addition to the POCSAG-friendly amateur radio equipment that has been available for some time. This shows an heartening paradigm shift from simply monitoring systems to hacking and re-purposing cast-off technology to be used for the implementation of hobbyist-type systems; a time-honored tradition among amateur radio operators and other technological hobbyists.

I'll start with the actual pagers themselves. I've seen dozens of these in the bottom of "make offer" bins at hamfests, and I'm reasonably sure that you can probably pick them up for no more than a dollar or two apiece. Usually, ten or twenty bucks will get you the entire contents of a "make offer" bin, and the seller will throw in the bin just so that he or she doesn't have to load it back in their vehicle. The units you want to look for are the 1980s and early 1990s vintage POCSAG and tone pagers on VHF

and UHF frequencies. The older tone and numeric pagers, such as the Bravo series, are useful in two ways. They can have their frequency changed to a nearby ham band, and used as actual pagers, or you can salvage the very nice receiver board out of them, and use it in another project. From a frequency-changing standpoint, the pagers will be either crystal-controlled or computer-programmable. For those with access to the correct programming software and accessories, the latter are quicker and easier to reprogram. Otherwise, go with the rock-bound boards.

I previously mentioned the Motorola Maxtrac and Spectra. These are readily available surplus, can be easily converted over to the ham bands, and work very well for transmitting POCSAG data. Using these radios is one of the quickest and easiest ways to get a "discriminator tap" for monitoring low-speed wireless data. You will also want to keep an eye out of ham rigs that are advertised as "9600 baud packet ready". This feature is very common in Yaesu and Alinco VHF/UHF ham rigs.

Other Cheap Ham Gear

Even with my HPJIE, I still get a case of sticker-shock when I visit the local ham shops and look at the prices on the new gear. Like any frugal basement techie, I look for less expensive solutions to get on the air. I have previously mentioned surplus commercial LMR gear, and there are good inexpensive ham rigs available as well.

Most hams start out with a handheld (HT) that operates on the 2m (144-148 MHz.) and 70cm (420-450 MHz.) ham bands. These are VHF and UHF bands, respectively, and are the most popular for local communications. They are both next to the most popular land mobile radio bands in the country. This close proximity also means that a "dual-band" radio, as they are known in amateur parlance, usually has extended receive frequency coverage into the VHF-high (148-174 MHz.) and UHF (450-512 MHz.) land mobile bands. This is handy if your local public safety agencies happen to run on an analog radio system in VHF-high or UHF, especially if you live someplace like New York where hams and ham gear are exempt from mobile police scanner laws. There is a plethora of dual-band HTs out there, as well tri-band and quad-band HTs that include other VHF and UHF ham bands: 6m (50-54

MHz.), 1.25m (222-225 MHz.), and 23cm (1240-1300 MHz.). Of these extra bands, the one worth the most consideration is the 6m band due to its exceptional performance in hilly and rural areas compared to 2m and 70cm. The vast majority of local ham traffic however, especially ARES/RACES and Skywarn, is going to be on 2m and 70cm in that order.

Before going into specific models, there are a few requirements that I have for any radio to be used in a preparedness context. The radio has to be fairly rugged. It should have the capability of running on 12V DC. If battery operated, it should be able to run on common household alkaline batteries (AA or AAA). It should be able to use an external (vehicle or base) antenna without hassle. If possible, it should be able to be repaired on a homebrew ham's workbench with commonly available tools and parts. The last item is of importance as there may come a time when you simply won't be able to jump on the Internet and order a new one if your radio breaks. Long-term sustainability and resiliency should be a top priority when it comes to your gear choices, but that's a topic for another time.

I'll start with the current basement bargain in HTs, and that is the various brands and models coming in from China. My ham friends and I have played with a few of them, and have had generally positive experiences with the Weierwei, TYT, and Wouxun brands. They average about \$120 for a dual-band HT, although if you could do without 70cm, you can get a 2m only HT for under \$100. Despite initial concerns about reliability and ruggedness, the radios so far have held up to the usual use and abuse. External antennas are no problem. They have a SMA-male connector on the HT, and adapters are available for the standard BNC and SO-239 antenna connections. For power versatility, you can get 12V DC adapters and AA battery packs. My only concern with them is long-term sustainability. The radios definitely fall into the disposable category. As a cheap radio for the beginner however, they're more than adequate.

With the China-made HTs hitting the country at under \$100 for some models, the price of used HTs has been driven down to the point where an astute ham can get a nice rig

dirt cheap. Good working late 1970s to 1990s vintage HTs, both amateur and commercial, are available for just under the price of a new Chinese model. You could find a good front-panel programmable commercial HT at a reasonable price, but you're more likely at a hamfest to run into some older ham HTs. The Eham website has a good review section of older gear, and by using that combined with the requirements I talked about earlier, you can find a whole bunch of late-model gear that will do the job for you. The older gear is definitely built to a more rugged level, and may also be repairable on the homebrewer's workbench. Some other things that work in your favor here are the fact that the average ham would rather buy a new China-made HT than mess around with the older stuff, and that regular household battery or 12V DC (vehicle) operation was considered the norm back then for HTs. My favorite HT from the 1980s is the Icom IC-02AT series. They were made for 2 meters (IC-02AT), 220 MHz. (IC-03AT), and 440 MHz. (IC-04AT).

While I have made some good long-distance contacts on low-power 2 meter FM simplex while hill-topping, the simplex range on 2 meters, with a HT, is generally only a few miles. The VHF bands are line-of-sight bands, and range is typically limited to such. The amateur radio operator looking to communicate beyond the local area needs to go lower in frequency, and look at HF communications. HF gear costs more than VHF/UHF gear, but you are getting much more radio for the price. Where your dual-band HT covers 2m and 70cm, an HF rig covers all the "shortwave" amateur bands from 1.8-30 MHz. The usual beginner starts with a standard 100 watt base station made by Icom, Kenwood, Alinco, or Yaesu. There are way too many models to list, but one can examine the reviews on Eham to get an idea of what rigs are considered decent. A check on Ebay shows that a late-model HF rig advertised in working condition can sell for as low as \$300, although \$500-550 is more realistic. As a comparison, the least expensive new HF transceiver I've found is the Alinco DX-SR8T at \$530. The other brands price their entry-level transceivers closer to \$700. These prices don't include a power supply, antenna, tuner, or any accessories. Add another \$150 for the correct power supply, although most of us run them with a deep-cycle marine battery, and a

battery charger. That knocks about \$50 off the price. Going that route, if you look around with a frugal eye, you can get into an entry-level HF station for around \$400-\$500. That's still four times what you spent to get on two meters, and maybe twice of what you're able to afford. No problem. There are still other, less expensive, ways to get on HF.

Check this page out: <http://www.neoanderthal.com/wa7mlh.html>. This gentleman builds his own HF gear out of parts he picks up cheap or free at hamfests. He strips down old gear, and rolls his own radios. HF on a poor man's budget is definitely possible, especially if you are willing to invest some time and learn about homebrewing. My first recommendation is to visit this website: <http://www.wb8zcc.com/homebrew.html>. Once you've read that, then hit the local hamfests for parts and technical literature.

I previously mentioned the ARRL Handbook and how you should have a recent copy in your library. The other book I recommend is going to cost you \$50 new, but I've found it to be well worth the cost. It is Experimental Methods in RF Design (EMRFD). This book isn't as filled with projects like the ARRL Handbook, but instead shows you how to design your own gear in a modular fashion. If you aspire to build



functional ham radios from parts scrounged out of junk electronics, this is one of the best books you can get. Consider the \$50 you spend as an investment in yourself. If you look for it on Amazon, you won't have to pay full price. When reading EMRFD, pay attention to Chapters 1: Getting Started, 7: Measurement Equipment, & 12: Field Operation, Portable Gear and Integrated Stations.

Reading and understanding these books will best equip you for what I think the best HF communications approach

for the frugal ham operator. That would be using homebrew/QRP equipment and operating techniques. For starters, it is considerably less expensive than the 100 watt appliance route. If you pay attention at hamfests, you can get on the air for less than \$200. It has lower electrical power requirements. A 100 watt transceiver is going to require a power supply that delivers at least 25 amps at 12 volts. QRP gear can run on common inexpensive 12volt, 2-5 amp hobbyist power supplies (usually scrounged from someplace), or on a 12V, 7AH rechargeable gel-cell battery.



Going DIY ensures you can fix it yourself with common parts, and basic tools and test equipment. This may not be the case with modern, commercially manufactured gear. This approach entails making a personal investment in yourself. You'll need to learn something about RF electronics. It's not difficult, people of all ages and backgrounds become ham operators and do it. If you, like many people, have more time than money at present, it really is the best approach. It will also make you a better ham operator.





The Computer Corner

by Joshua Tower

Greetings, fellow hackers. Welcome to The Computer Corner, my little virtual space in the pages of Basement Techie. Here I'm going to talk about whatever computer topics strike my fancy at the moment, whether it's hardware hacking, non-Windows OSes, software fun, microcontrollers and SBCs, or "computer security" to quote a certain euphemism. My handle (for the moment) is Joshua Tower. I've been hacking since the 1970s. I suppose that makes me old enough to know better and not give a fuck at the same time. Got my start on a Commodore PET that a friend's dad

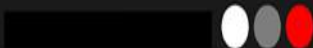


brought home from work, and since then have managed to scrounge enough machines and computer time to get one of those cool computer jobs our guidance counselors warned us about.

One of the reasons Ticom started up Basement Techie was to show all the geeks how to do things on the cheap. Not quite at the stone tools and yer bare hands level, but for a lot of us our budget consists of a few bucks to look for cast-offs at a flea market or Goodwill, supplemented by the occasional dumpster dive. Not having a lot of play-money should not be a reason to be unable to hack.

Getting Your Old Box Up and Running

So you find an old PC with all its hardware intact and working off the curb or at the local Goodwill, but the previous owner either wiped or removed the drive. Replacement drives are not a problem, and you probably have a stack of them on a shelf somewhere. What do you do for an OS?



Windows is notorious for making hardware "obsolete" as newer versions require more "up-to-date" hardware to run at any decent speed. The answer is to put Linux in it. There are several versions of Linux available for free download that are geared towards older hardware. Some of the better known ones are:

Xbuntu - One of the more popular distros, a lightweight version of Ubuntu. There are also other lightweight distros based upon Ubuntu.

Puppy Linux - One of my favorites. Runs off RAM as low as 128 MB.

Damn Small Linux - Another favorite.

Bodhi Linux - Good for real old hardware. Minimum system requirements are:

300mhz i386 Processor

128megs of RAM

1.5g HD space

Tiny Core Linux - Another really



small distro that's good for older hardware.

The nice thing about Linux distros is that they are free. You can try different ones and go with what works best for you. For more info, check out the following web sites:

<http://xubuntu.org/> - Xbuntu

<http://puppylinux.org/> - Puppy Linux

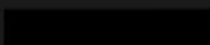
<http://www.damnsmalllinux.org/> -
Damn Small Linux

<http://www.bodhilinux.com/> - Bodhi
Linux

<http://distro.ibiblio.org/tinycorelinux/> - Tiny Core Linux

Cheap Hardware For Experimentation

Old discarded computer systems are everywhere. I find them on the curb, at Goodwill, tag sales, flea markets, and in dumpsters. Usually they have their hard drives pulled from them, but drives keep going up in space and down in price. Vendors



will almost give away the not-so latest and greatest at computer shows just to get rid of it. The same applies to local computer stores with the "old shit in the back." Look around. You'll find stuff and won't have to spend a lot of money.

There are two modern systems that don't cost a lot and are well suited for experimentation. They remind me of the old \$100 days, only better! They are the **Arduino** and **Raspberry Pi**. Both are really cheap, open source, and have a large community of hackers working with them and supporting them. Rest assured I'll be writing more about them in future issues of the magazine.

<http://www.arduino.cc/> - Arduino Website

<http://www.raspberrypi.org/> - Raspberry Pi Website

Until next time, keep on hacking!

-Josh






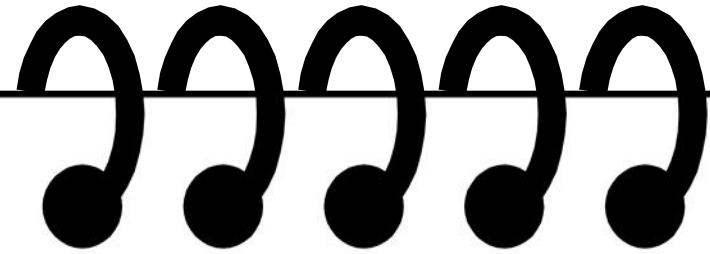
Workshop Wisdom

By Dog Solitude

We have previously talked about the importance of having a proper workspace and workbench for your research and projects, and how one can be set up in a small area. Once you have a space set up, you'll want to stock it with tools and test equipment. Here is a starter list of items that you should get if you are starting your own workshop/lab from scratch. This list will have you set-up for a small basic electronic lab and light mechanical workshop.

- Allen wrench set, standard and metric - most people get a 1/4" multi-bit screwdriver and assorted bits.
- Dremel tool, with assorted bits.
- Drill Press
- Alligator clip-leads
- Drills, electric and hand-powered, with bits
- Amplified speaker, battery-operated with test-leads. Radio Shack cat# 277-1008
- Electronic component collection
- Bench Grinder
- Frequency counter, 3 GHz. portable
- Bolt cutters, 24 inch
- Hammer, ball-peen, 16oz.
- Computer, with open-source OS installed (Linux or BSD)
- Hammer, claw, 16oz.
- Crimper, terminal
- Hand sledge, 3 lb.

- 
- Heat gun
 - Helping hands
 - Hobby vise, small
 - Multimeter
 - Needlenose pliers, 6 inch
 - Nibbler tool
 - Nutdriver set, standard and metric
 - Oscilloscope
 - Pliers, adjustable (slip-joint)
 - Pliers, tongue & groove, aka "Channellock"
 - Prototyping board
 - Radio communications receiver, wide-band
 - Screwdriver set, multi-bit, with bits for hex, square, torx, & tamper-proof variants
 - Screwdrivers, regular & phillips, in various sizes
 - Socket wrench sets: 1/4", 3/8", 1/2" (standard and metric.) You can get away with just a 1/4" and 3/8" set, but I've found the 1/2" set to be better for larger jobs.
 - Solder sucker
 - Solder-wick desoldering braid
 - Solder, 60/40 rosin-core
 - Soldering iron stand
 - Soldering Iron, ~100 watt
 - Soldering iron, 25-50 watt
 - Tamper-proof bit set - most people get a 1/4" multi-bit screwdriver and assorted bits.
 - Tool boxes and tool bags.
 - Tool set, precision.
 - Torch, small Butane
 - Torx driver set - most people get a 1/4" multi-bit screwdriver and assorted bits.
 - Utility/hobby knife, replaceable razor blade type, with spare blades.



- Variable-voltage power supply
- Wire cutters, aka diagonal cutters
- Vise grips: 10wr, 6ln, others according to preference
- Wire strippers
- Vise, bench-type
- Wrench set, combination, standard and metric
- Volt-ohm meter (multimeter)
- Wrench, adjustable, ~6 inch

Where would we go from here? That would depend on where you want to specialize. If you were getting more into the fabrication and mechanical side of things, then a small lathe or combination lathe/mill, sheet metal brake, and maybe a welding rig would be a good idea. For those who are electronics/RF oriented, we'd suggest a spectrum analyzer, signal generator, dip-meter, and a network analyzer.

The first accomplishments are always the most memorable.

- Tuning above the FM Broadcast Band on a multiband radio you found at a tag sale, hearing Morse Code and a recorded voice with weather conditions, and realizing that there's a whole invisible world out there to explore.
- Firing up that Commodore VIC-20 scant minutes from when it was grabbed from under the tree and unwrapped. Typing in two simple lines of BASIC code that changed your life forever:

```
10 PRINT "HELLO WORLD"  
20 END
```

- Throwing a length of wire out the window of your bedroom up into a nearby tree limb, hooking it up to your Radio Shack DX-100, and hearing voices from across the ocean.
- Adding an extension for your modem off your parent's phone line, and being rewarded with the sound of a dial tone when you are done. Then connecting to an entire community of shared interests that spans the globe.
- Taking a handful of electronic parts, a schematic from a book, and having it work after you solder it all together. Or not having it work, figuring out the problem, and fixing it.
- Your first real job in high school being in a TV shop or computer store, instead of the local fast-food joint.
- Realizing that your hobby has more than enough potential to be a good-paying job doing something you enjoy.

Most of us started small. We didn't have a big budget, and our lab was the corner of a bedroom or basement. We scrounged what we could, learned all we could, and on the weekends (if we weren't working) hacked until the break of dawn. For many of us, our techie skill-sets kept us in

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